The MONITOR

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Volume 5, No. 5 - Public Release Number 0998 **September, 1998**

Air Force Plant 44 Pollution Prevention Success Story *(see page 9)*

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The MONITOR is a quarterly publication of the HQ AFMC P2IPT dedicated to integrating environment, safety, and health related issues across the entire life cycle of Air Force Weapon Systems. AFMC does not endorse the products featured in this magazine. The views and opinions expressed in this publication are not necessarily those of AFMC. All inquires or submissions to the MONITOR may be addressed to the Program Manager, Cliff Turner.

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THE MONITOR ON INTERNET

This issue of the MONITOR is available on the Internet at the ASC site (http://www.ascem.wpafb.af.mil). The current issue of the MONITOR is in a Portable Document Format (PDF) file which requires a reader program for viewing or downloading. The Adobe Acrobat reader is available for downloading at not cost.

GOVERNMENT AND INDUSTRY PARTNERING TO PREVENT POLLUTION

The best way to prevent pollution is to eliminate it at its source. Get it out of the products you buy and you won't have to worry about getting rid of it later. Sounds simple? This up-front approach has proven to be both a technical and contractual challenge for the Department of Defense. This is because manufacturers are often forced to use hazardous materials like lead-based electrical printed wiring boards and carcinogenic chromium-based paints to satisfy demanding military performance requirements. New environmentally preferable alternatives to dangerous materials are appearing in the commercial market daily, but are often too difficult and expensive for any one military procurement office or defense contractor to independently qualify for their special needs. In addition, most contractors make many different products in the same factory for different customers. They would like to use the same materials and processes to manufacture all their products, but frequently can't because technical specifications are established at different times and serve a wide range of soldier, sailor, and airman needs.

So how do you get rid of hazardous materials while maintaining product performance? The answer is you get the Government buying activities doing business with a contractor together with that contractor and form a partnership. The partnership, or "Management Council," can work any issue of mutual concern, pollution prevention being just one that is commonly shared. When the Council identifies a shared need to replace a hazardous material, it can solicit the support of a unique multi-Service group called the Joint Group on Acquisition Pollution Prevention to assist them in what the Department of Defense calls an Acquisition Pollution Prevention Initiative. Once test criteria are agreed upon, tests are conducted with the costs of performing them shared among the military customers and the contractor. After the best alternative to the hazardous material is found, all contracts are changed at one time as a Single Process Initiative, which allows the Government and contractor start using the environmentally preferable alternative right away.

For example, a Management Council with the Raytheon Company received support from the Joint Group on Acquisition Pollution Prevention to test and qualify a new paint process that involves chemical agent resistant powder paint technology. This team focused on eliminating the release of volatile organic chemicals, or hazardous fumes, that occur during paint spraying. The Joint Group succeeded in qualifying a non-hazardous material for painting applications and implemented it using a Single Process Initiative to make a multi-contract modification. The new process satisfies a wide range of camouflage and infrared resistant paint finish requirements. There is also a significant reduction in manufacturing time with a material cost savings of $1.20 per square foot. Increased surface durability allows machining after painting, which eliminates masking operations. Process time has been reduced by as much as three hours per piece part with a cost avoidance of at least $500 thousand per year. The environmental payback thus far has been a reduction of paint emissions by 40 tons per year, waste water disposal by 40 tons per year, paint sludge disposal by 20 tons per year, and waste solvent treatment by 20 tons per year.

Another example is a Joint Group on Acquisition Pollution Prevention Partnership with an association called the Circuit Card Assembly Materials Task Force. Acting on behalf of at least four Management Councils simultaneously, this joint military and industry collaborative effort is focused on qualifying lead-free organic and metallic printed wiring board surface finishes to replace the commonly used tin-lead based printed wiring boards. The partnership is also developing guidelines for intelligent use of conformal coatings with the focus on reducing usage of hazardous materials where possible. The initiative, involving 20 companies and Government organizations, benefits 49 military weapon system programs and four defense contractors. The $5 million needed to complete performance testing is being shared among the participants. The benefit from simplifying production processes and reducing the amount of hazardous materials in circuit cards at the four defense contractor factories participating in this project is estimated at over $3 million per year. Similar benefits will be realized at military depot facilities where circuit card maintenance is performed.

A third example is an aircraft paint primer Acquisition Pollution Prevention Initiative. The purpose of this Management Council partnership with the Boeing Company is to eliminate the need for cancer causing chromium in aircraft paint. The cost of testing alternative paints is $1.3 million, which is being shared by the Air Force, Navy, and Boeing. However, the Joint Group on Acquisition Pollution Prevention is projecting a $31.3 million payback for military depot maintenance facilities maintaining Boeing aircraft. This is because they will not have to employ expensive safety and disposal procedures when they strip and repaint every few years. Boeing also anticipates that it will eliminate 654 pounds of chromium per year from its manufacturing facilities, improving worker safety and reducing hazardous material handling costs. Had the six Air Force and Navy procurement activities participating in this initiative undertaken it independently, the cost for testing and validating paint alternatives could have reached $7.5 million. Combining testing requirements, sharing results, and implementing a Single Process Initiative multi-contract change avoids $6.2 million in duplicative efforts.

A fourth and final example is what occurred in Kimhae, Korea when the Defense Contract Management Command worked a Single Process Initiative to change all military contracts with Korean Airlines (KAL) and allow the reuse of plastic beads to remove old paint. KAL has been serving the United States for decades providing high quality Depot Level maintenance for the Air Force F-15 Eagle and F-16 Falcon, and Marine Corps CH-53 Sea Stallion. The Management Council formed with KAL agreed last year to a Single Process Initiative contract modification, which permits KAL to prepare aircraft for repainting by removing old paint using plastic beads ejected through a high-pressure hose. After using the beads, KAL collects, cleans and is now allowed to reuse them. This eliminates the need for hazardous chemical paint strippers and cuts waste disposal, which reduces repainting costs by over $900,000 per year. It also allows KAL to continue servicing forward-deployed aircraft in country rather than incurring the cost of shipping them out, which results in savings and continued readiness for the Air Force and Marine Corps.

Management Councils are providing an excellent way to start Acquisition Pollution Prevention Initiatives and initiate procurement reforms. The Council, along with technical and business support from the Joint Group on Acquisition Pollution Prevention, offers an effective and efficient way to validate environmentally preferable materials and processes. Once approved by the Council, an alternative can be implemented through a Single Process Initiative contract change. An added benefit is that the entire testing process and results are documented and posted to the Internet web site at http://www.jgapp.com/ for anyone to access and learn from.

This article was submitted by Mr. Sydney Pope, DCMC. ■

OVERVIEW OF THE F-22 WEAPON SYSTEM HAZARDOUS MATERIAL (HAZMAT) PROGRAM

The F-22 Weapon System HAZMAT Program was developed to ensure that adequate consideration be given to the elimination, minimization, and mitigation of hazardous materials, as well as environmental, safety, and health (ESH) concerns and the compliance of hazardous materials. The HAZMAT Program focuses on those materials and processes involved in post-delivery operations (operation, maintenance, support, and disposal) and for end item materials of potential concern in post-delivery operations.

Prior to Critical Design Review (CDR), the HAZMAT review process (see Figure 1) concentrated on design decisions. Since CDR, the HAZMAT Program has focused on reviewing materials being selected by maintainers

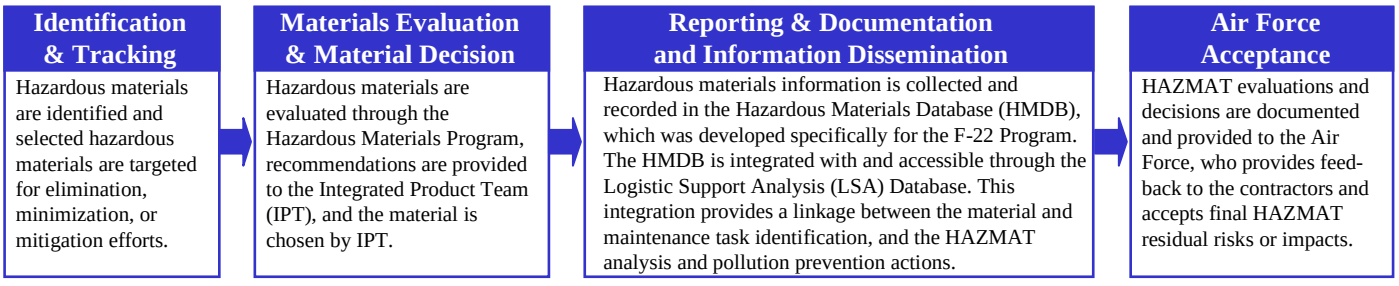


Figure 1. Air Force/Contractor HAZMAT Program Review Process (F-22)

for technical orders covering operational base tasks. In addition, the HAZMAT program is playing an active role in the transition of F-22 aircraft to Air Force bases. A partial listing of some of the pollution prevention successes associated with the F-22 Program have been summarized in Figure 2. Specific details related to one of these success stories, namely, the elimination of cadmium on the F-22 landing gear, is presented as a separate article below.

F-22 HAZMAT Program's Pollution Prevention Successes

- EPA Stratospheric Ozone Protection Award for Leadership in Ozone Layer Protection.
- Cadmium plating, a finish system long used for corrosion protection is being replaced on the F-22 landing gear.
- Minimized or eliminated Volatile Organic Compounds (VOCs) used in coatings, chrome in sealants and anodizing, and methyl ethyl ketone (MEK) wipe solvent.
- Eliminated the use of methylene dianiline in adhesives.
- Brush/roll applications are being developed for selected coatings, thereby reducing the requirements for spray application and associated spray related health issues, HAZMAT usage quantities, VOC emissions, and hazardous waste.

Figure 2. F-22 P2 Successes

Further details on the F-22 Program can be viewed in the May 1997 issue of the MONITOR. ■

F-22 SUCCESS STORY: REPLACEMENT OF CADMIUM ON LANDING GEAR DURING THE MANUFACTURING PROCESS (EMD PHASE)

Cadmium plating, a finish system long used for corrosion protection, is being replaced on the F-22's landing gear. It was initially the primary corrosion protection finish being used on the landing gear. The F-22 finish specification approved cadmium plating or IVD Aluminum for high strength steel. During the F-22 Prototype Program, cadmium plating was selected based on lower manufacturing costs and confidence in cadmium plating. However, several factors have led the F-22 program to re-evaluate the use of cadmium on landing gear. One of these factors includes stringent cadmium environmental and OSHA regulations (see Figure 3) that ultimately will impact overall cost.

Cadmium Regulations Cost Impacts

- Hazardous Waste Disposal (includes Blast Media)
- Wastewater Treatment
- Sludge Disposal
- Blast Media
- Air Emission Control Technology Requirements under the Clean Air Act
- New OSHA standard of 5 microgram/M3 will impact medical monitoring, facilities, PPE requirements

Figure 3. Cadmium Regulations Cost Impact

Ogden Air Logistics Center provided an estimated cost impact of $930,000 - $3,000,000 at Hill AFB for the continued use of cadmium on landing gear, as the sum of all one time and recurring costs for a period of 20 years. These costs included capital costs (facility modifications and equipment) and operating/maintenance costs. The cost estimate consisted of known costs and cost estimates, based on new, recently changed, or pending regulations. It was assumed that by the time the F-22 would arrive at Hill AFB for overhaul, most of the components now in service with cadmium plate would have been returned for overhaul and the cadmium would have been replaced with a more environmentally friendly coating.

Ogden Air Logistics Center and the F-22 WS HAZMAT Team, strongly advocated for the Single Program Office (SPO) to fund an evaluation study for alternative finishes and the associated replacement cost. In response, the SPO funded this study, which also included fatigue testing of the alternative finishes. IVD Aluminum was identified to replace cadmium plating on external surfaces, and a metallic-ceramic coating was identified for parts with deep internal diameters or threaded parts.

The F-22 SPO then funded the implementation of these cadmium replacement finishes on the F-22 landing gear. Partial incorporation of these replacements is already being achieved on A/V 4001 – 4009. The remaining cadmium plated parts to be converted had been ordered before the change was approved. Full incorporation will be achieved on A/V 4001. Bushings will remain cadmium plated because no dimensionally controllable substitute has been found with adequate corrosion protection properties. Implementation of cadmium replacement finishes cost $406,000 for the 9 F-22 EMD aircraft. Post EMD replacement costs have been estimated at $3,575 per aircraft.

For further information, please contact Mr. Perry Beaver at DSN 785-4976 ext. 2230. ■

ARNOLD ENGINEERING DEVELOPMENT CENTER (AEDC) MANAGES ITS OPERATIONS UNDER A PRODUCT WORK BREAKDOWN STRUCTURE

Arnold Engineering Development Center (AEDC), which performs ground testing of aircraft, aeropropulsion, and space and missile systems for Air Force, DoD, and commercial customers, manages its operations under a Product Work Breakdown Structure (WBS) to implement Activity Based Costing and reduce operational costs. Since 1988, AEDC's Total Obligational Authority (TOA) has been decreasing at a rate of 19 percent by 1998. By using a product-focused WBS, AEDC can identify its cost drivers and focus on reengineering its overhead processes to decrease overall costs of operation. Details related to AEDC's efforts to reduce costs using the WBS are provided below.

Overview of AEDC's Historical Funding Profile

Figure 4 summarizes AEDC's Strategic Management Model, including strategic objectives taking the Center into the next century. In the future, the basic infrastructure of AEDC's test cells must be more productive, automated, and better maintained. The workforce must be better trained, equipped, and more satisfied with its

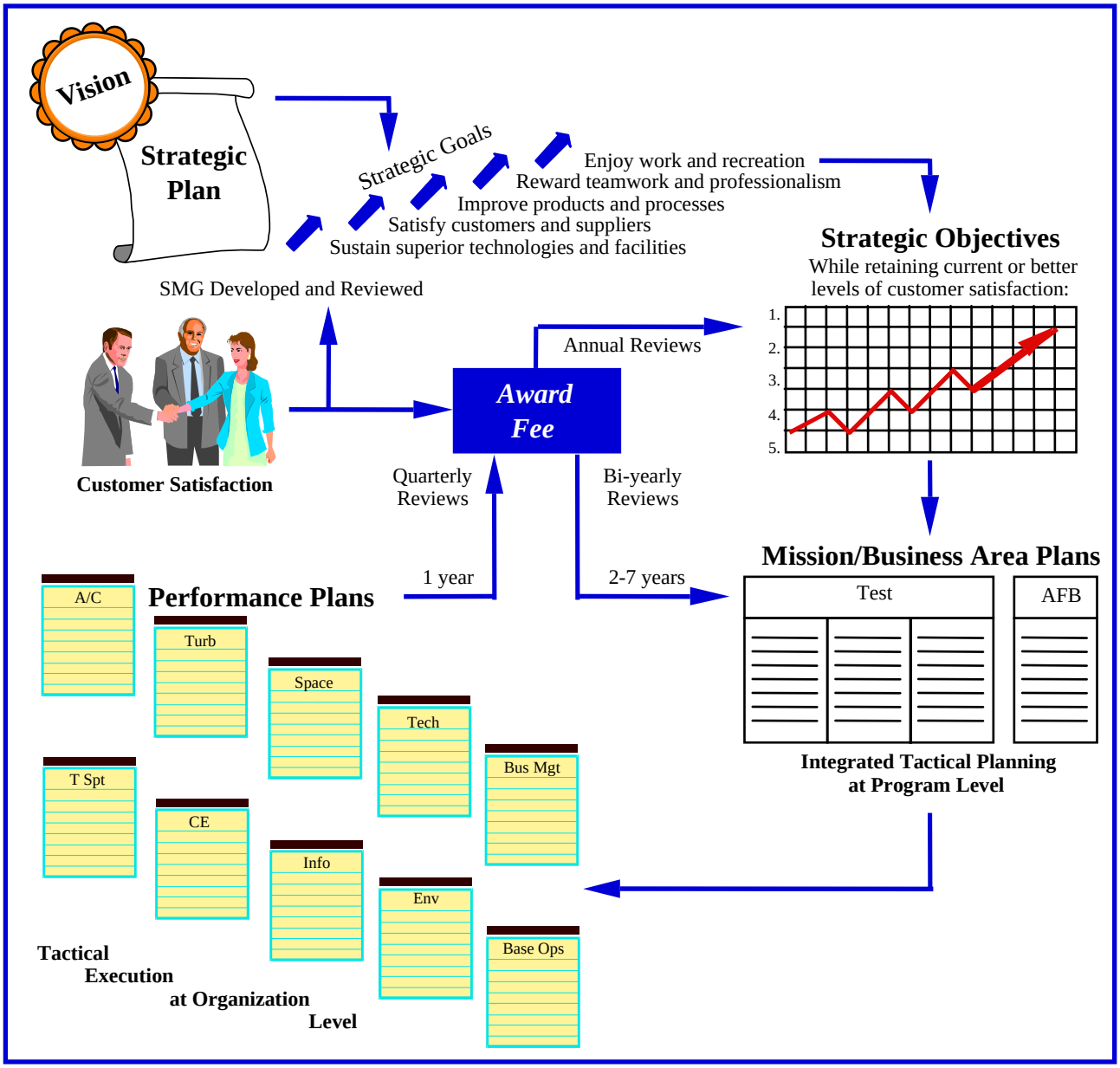


Figure 4. AEDC Strategic Management Model

work environment. Working conditions must be safer, cleaner, and more secure. The challenge of meeting these objectives is further compounded by declining budgets. Figure 5 summarizes AEDC's cost of operations in FY97. Approximately 36% of AEDC's funds required for operations now come directly from its customers.

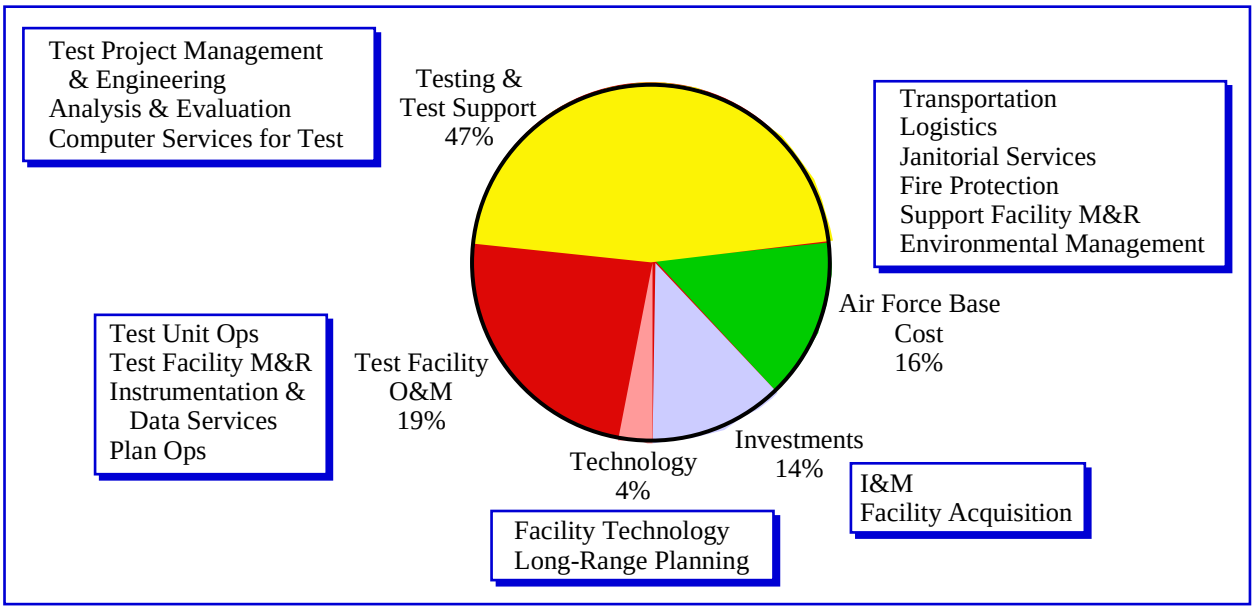


Figure 5. Cost of Operations
AEDC FY97 TOA = $317.2M

The challenge facing AEDC is to streamline operations and provide customers with a superior product at the lowest possible price. This requires reducing infrastructure support and/or test facility maintenance costs and removing inefficiencies wherever possible. Environmental management is one of the support functions for which AEDC is establishing cost reduction measures. Details about AEDC's plans to allocate total costs of its services are described below. Specific details about the activities of the Environmental Management Directorate (AEDC/SDE) are included in this discussion.

AEDC's Business Elements

AEDC's mission areas include corporate services, test operations, and USAF base services. Figure 6 summarizes the relationship between AEDC's organization and its WBS. The WBS for AEDC's three product lines are used to plan/define work, allocate and reallocate budgets, and advocate needs. AEDC's organizational elements are responsible for assigning and accomplishing work, organizing, training, and equipping the workforce, and managing its skill mix. For example, the costs of AEDC/SDE's operations in support of Space and Missiles systems testing could be assigned to the appropriate facilities and operations and

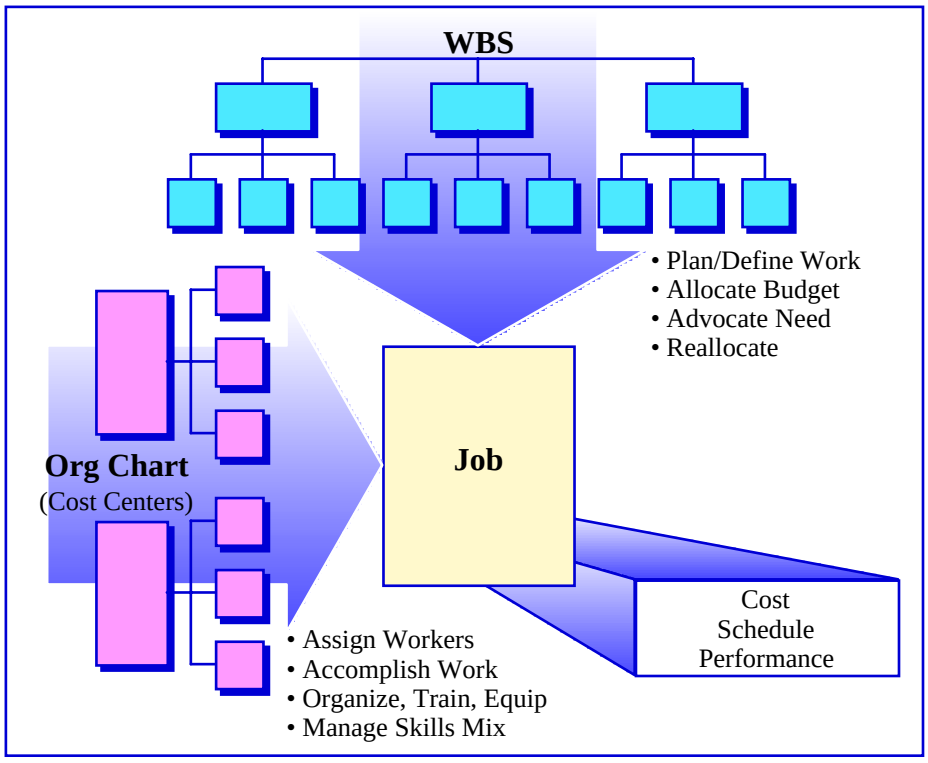


Figure 6. WBS Vs. Org Chart

their related test products. Both short and long-term environmental costs of maintenance and operations could be assigned to the test cells that generate those costs. To date, all costs of actual operations and maintenance are assigned in this manner.

The synergy established by this combination allows AEDC to plan and manage its work at optimum cost, schedule, and performance. AEDC's product line managers have visibility into and ownership of true product costs, and can make informed business decisions.

Overview of Environmental Management Integration into the Product WBS

AEDC/SDE's goal is to integrate all environmental management costs into the Product WBS. As an interim initiative, AEDC/SDE manages its operations using a WBS that follows the Air Force Environmental Pillars (i.e., Restoration, Compliance, Conservation, and Pollution Prevention). To date, AEDC/SDE's costs within each pillar are used in long-range business planning to establish goals, which are then translated into yearly performance plans (as described in Figure 4 on page 6). This interim WBS has allowed AEDC/SDE to streamline its operations by being able to identify (for example) cost drivers for hazardous waste management, and to evaluate cost data on a quarterly basis.

To fully incorporate AEDC's Environmental Management costs into the product WBS, AEDC/SDE is identifying the annual expenditures of each product line for environmental management activities that go beyond AEDC/SDE's operational costs. This will provide AEDC's product line managers with visibility into each product line's environmental management costs. With the collection and analysis of these costs, AEDC/SDE will transition costs associated with each test product line and the test cells that create test products into the product WBS. When this transition is complete, AEDC/SDE will have transferred responsibility for environmental management costs to the Center's product line managers. Just as with maintenance costs, environmental management costs will be understood and managed by those responsible for creating products needed by AEDC's customers.

For further information regarding AEDC's Product Work Breakdown Structure, please contact Ms. Sandy Snyder at DSN 340-4720 or commercial (931) 454-4720. For further information regarding AEDC's Environmental Management Program, please contact Mr. Clark Brandon at DSN 340-7414 or commercial (931) 454-7414. ■

THE ALTERNATE MATERIAL SELECTION SYSTEM FOR CADMIUM

The U.S. Army Tank-automotive & Armaments Command (TACOM) has recently developed the Alternate Material Selection System for Cadmium (AMSS-Cd). The AMSS-Cd was created to help design materials engineers in the difficult task of identifying appropriate alternatives to cadmium electroplating. Analysis tools are proposed in the AMSS-Cd to use qualitative ratings for the performance of alternate materials to select non-cadmium material specifications for TACOM applications.

In addition to the interactive tool provided by the AMSS-Cd, a supporting technical report provides a summary of the alternate materials, their properties, and the major TACOM applications of cadmium plating. The combination of the analysis tool and supporting technical information serves as an excellent tool to aid in the elimination of cadmium from U.S. Army weapon systems.

For more information, please contact Paul Decker of TACOM-TARDEC at (810) 574-8711, or Pete Ault of Ocean City Research Corporation at (609) 399-2417. ■

AIR FORCE PLANT 44 SEEKS EARTH-FRIENDLY REPLACEMENTS FOR HAZARDOUS CHEMICALS

Organic chemical solvents have always been considered the most ideal substances for an array of industrial purposes — from cleaning oils and greases from metal parts to stripping paint from surfaces. It was found, however, that these chemicals can be hazardous to human health and the environment. In the wake of that knowledge, a nationwide, if not international quest has emerged to find earth-friendly replacements for chemicals and other hazardous materials.

At Air Force Plant 44 in Tucson, AZ., a pollution prevention team was formed in the late 1980s to tackle this worthwhile challenge. Engineers from the Aeronautical Systems Center, Acquisition Environmental Management and Raytheon Systems Co., which operates AFP 44, have been working together to uncover new technologies and methods that will replace chemicals used at the plant's missile manufacturing facilities.

Headed up by ASC's 1Lt. Saulo Cepeda and Paul Fecsik of Raytheon, a few of the team's early successes were the elimination of two hazardous materials: 1,1,1- trichloroethane and formaldehyde. "Plant 44 has had an aggressive program since its inception," said Cepeda. "For instance, a few years ago we were able to eliminate ozone-depleting substances from all of our processes and PCB (polychlorinated biphenyl) transformers."

In conducting its program, the team follows a systematic approach designed by the Environmental Protection Agency (EPA) to replace or eliminate chemicals currently used at the plant. Under the plan, called the EPA pyramid, the first priority is to reduce hazardous chemical use at the source. This means the existing production line may require a new technology, a change to the manufacturing process, or an alternative substance to prevent pollution at the source while meeting product performance standards. If this can't be accomplished, the next choice is to recycle, reuse or reclaim the chemicals. Third on the hierarchy is the option to treat the waste chemicals before discharging, in accordance with regulatory limits. Last on the pyramid is disposing of the chemical at a permitted facility.

"Our first priority is to completely eliminate the hazardous portion of the industrial process," said Fecsik. "If this can't be done, we next attempt to isolate and recycle the material."

Using the EPA pyramid, the AFP 44 team has adopted its own strategic plan. Concentrating on four key areas — hazardous material elimination, chemical recycling, hazardous waste reduction, and water recycling activities — team members have achieved a dramatic drop in chemical use across the installation.

One of the projects responsible for that victory is the powder paint process. After researching ways to replace solvent-based paints, which emit volatile organic compounds (VOCs) when applied to surfaces, the team eliminated the material and replaced it with a powder paint composed of an epoxy or a polyurethane polymer combined with the desired pigment color.

"With traditional paint methods, you aim at a part and 80 percent can miss the surface and disperse into the air," Fecsik said. "The powder paint method puts a static charge on the part and the powder sticks to the component. The part is then heated and the powder melts to form a smooth surface. No volatile solvent is required to ensure a complete coating and provide necessary corrosion control."

The powder paint project, coupled with other pollution prevention activities, has helped the plant eliminate 15,000 pounds of VOCs.

Another promising venture, launched in 1994, has reduced hazardous waste generation by using water-based technology to degrease components. The environmentally-friendly aqueous systems, which operate similarly to a large dishwasher, have eliminated 1,1,1-trichloroethane and freon, formerly used in vapor degreasing operations to remove oils, greases and fingerprints from hardware.

In chemical recycling and reuse, several effective technologies have improved the way metals are removed from acid solutions in plating operations. According to Fecsik, strong acids are needed to remove oxides on metallic hardware. As the metals dissolve into the acid, the solutions become less active and must be disposed of with the resulting waste treated. Innovative acid purifiers were recently installed to filter out different types of metals, such as nickel, aluminum and copper, allowing the solutions to be reused indefinitely. Based on AFP 44's traditional consumption of nitric acid, these units are projected to recycle about 17,000 gallons of acid per year, according to Fecsik.

One of the newest projects on the horizon is a technology invented at the Mendeleyev University of Chemical Technology in Russia. Called electroflotation, the process causes gas bubbles to rise and trap trace metals and organic materials, which can then be separated from hard-to-treat wastewater discharges. Project engineers recently returned from a trip to Russia, with plans to build and test at AFP 44 the United States' first electroflotation unit. If successful, Cepeda said the technology will be transferred to other Air Force facilities.

With more than 10 years of demonstrated success, the pollution prevention team continues to search for new opportunities to reduce hazardous chemical use at AFP 44. "We know we can't eliminate everything that is hazardous, but we see big opportunities in the future to recycle existing chemicals and reuse wastewater. This is where we will achieve the greatest results in future projects," Fecsik said.

This article was written by Ms. Larine Barr and first appeared in ASC's Stakeholder Sentinel. ■

DESIGN FOR THE ENVIRONMENT COLUMN

FEEDBACK...

In the past, Environmental Safety, Occupational and Health (ESOH) specialists' may have found that they have been unable to be full participants in the early conceptual phases of product design teams. The ESOH individual's involvement in design teams may have been delayed until after the initial design was set in place. In today's' environmentally competitive market, the ESOH specialist is being involved early on in the design phase. The change in the participation of personnel can be attributed to the implementation of the concept of "Design for the Environment" (DFE), DFE requirements in the Air Force acquisition process and by ISO 14000.

Three questions are posed concerning DFE. The first question is what is DFE? And the second question is, are the any DFE success stories? And the third question is, where do I obtain more information on DFE?

Design for the Environment is a Program/Project decision making tool that allows a design team to consider the impacts of pollution prevention (P2), waste minimization, alternative materials and disposal issues in the pre-concept and concept development phases. Hazardous materials, ineffective processes and potential Environmental Protection Agency (EPA) compliance violations are designed out. And environmentally cost effective materials; best value processes and compliance with EPA rules are designed in. DFE is a "systems" approach to environmental design solutions. Successful implementation of DFE rests with a Project or Team leader who is inclusive the creation of the design group. Successful implementation of DFE is also attributed to participat-

ing functional organizations that know their respective roles and responsibilities and within the team structure.

DFE success stories are being documented in many publications sponsored by the EPA, government clearing houses and by the private sector. The *EPA Pollution Prevention ClearingHouse, Harvard Business School Journal* and the *University of Michigan Pollution Prevention Library* are a few of the sources that present case studies documenting DFE implementation. The *MONITOR*, contains sources of DFE success stories, as noted (for example) by the *F-22 Raptor Green Engine Concept*.

One excellent example of DFE in action is documented in the Flashjet™ paint removing process developed by McDonnell Douglas Aircraft (now Boeing). Flashjet™ is a removal process that uses high intensity light to remove paint. (See related article on page 13.) The flash of light burns the paint into a fine powder, without damaging the base material. McDonnell Douglas Helicopters was searching for a paint removal process that could be used on the Apache "D" Remanufacture program. The design team had conducted trade studies on differing chemical paint removal processes. Two processes were identified, one a traditional chemical process and the other being Flashjet™. The chemical process was initially chosen, because the light process obligated substantial up-front capital investment. Flashjet™ was shelved. The DFE design team conducted further investigations into the chemical paint removal process and discovered that while up-front costs were substantially lower than the light process, the clean up, disposal and compliance costs (for chemical) were cost prohibitive. Also, the potential for ecological damage and ESOH factors associated with a spill could have severe legal, and company image consequences. The design team went back and conducted additional research on the light process and found that up-front costs for Flashjet™ were in fact lower than the operational, support and disposal costs associated with the chemical process. An unexpected benefit was also reaped, by better working relations between Boeing and the EPA.

Flashjet™ is a prime example of DFE in action and it is an example of ESOH participation on a DFE team.

Fred Missel - Boeing

Fred Missel is the Boeing representative on the Joint Arizona Consortium for Manufacturing Training and Education (JACMET) Design for the Environment Group. He may be reached at 602-891-5648 or via E-mail DERFM@aol.com. ■

Many of the subscribers to the *MONITOR* may have their own DFE success stories, or they may have additional questions. To this end, the *MONITOR* will be creating a column dedicated to DFE. Projects highlighting DFE will be presented, questions will be answered and the sources for information will be provided. We look forward to your participation in the new column. Please contact Mr. Cliff Turner at DSN 785-3059 ext. 328 with your story and/or questions. ■

RAYTHEON SYSTEMS COMPANY ADOPTS DESIGN FOR ENVIRONMENT PRACTICES

Raytheon Systems Company (RSC) has adopted Design for the Environment (DFE) practices believing that the design selection offers the greatest opportunity to protect people and the environment. Their mission of developing, communicating and deploying process and tools needed for design and program teams to reduce hazardous materials and pollutants delivered in weapon systems or consumed in their life cycle process is facilitated by a multi-disciplinary DFE team. The program Integrated Product Team (IPT) is given the responsibility to manage product environmental, health and safety performance. This responsibility for functional requirements, cost, quality and DFE requirements is allocated to the lowest practice level. RSC has incorporated DFE tasks into concurrent engineering processes for design, development and program management as well as into systems, mechanical and materials and process engineering subprocesses. This provides life cycle coverage of product activities.

DFE guidelines and best practices such as design recommendations, program specific design guides, trade study criteria, training, classes, best practices databases, a program managers handbook and guidance in process capability analysis toolkit (PCAT) have facilitated DFE integration. Extensive application of DFE practices can also be attributed to the creation of a website for design teams. This website includes guidelines, trade studies and possible alternatives. Contact lists, training materials, discussion

boards and links to relevant websites are accessed greater than one thousand times a month by RSC employees.

The DFE initiation leveraged off commonalities with design for manufacturability/assembly and design for reliability/maintainability. Reducing and/or standardizing parts, fasteners, materials and hardware reduces or eliminates hazardous materials from glues and secondary operations such as cleaning, coating and finishing. Emphasis on the reduction or elimination of hazardous materials and pollutants in the product and its life cycle processes also compliments designing for affordability. The cost is cheaper, the quality better, and the schedule faster.

Conservative savings at RSC is estimated at exceeding one million dollars through the application of DFE practices. One success story at RSC involves the modified design to use powder paints. This decision, made through DFE practices, has resulted in a payback of $500,000 the first year alone. Reductions were made of VOC emissions (40 tons/year), waste water disposal (40 tons/year), paint sludge disposal (20 tons/year), and waste solvent treatment (20 tons/year). Three coating operations were streamlined into one, and a more durable coating has resulted.

RSC has successfully developed and integrated DFE practices resulting in a competitive advantage, demonstrating that the environment, safety, and health is too important not to be everyone's responsibility.

Raytheon Systems Company presented an overview of their DFE efforts at the AFMC Center Working Group meeting held in Dallas, TX in July 1998. ■

Requirements for Implementing a Successful DFESH

1. A supporting infrastructure must foster the implementation, including allocation of adequate human and informational resources.
2. All levels in the corporate culture must be aware of what DFESH is, what factors (such as global markets, directives, and regulations) are driving the need for DFESH program implementation, and what benefits DFESH can achieve. All levels responsible for implementation must be committed. Buy-in is essential at the board of directors and upper management levels.
3. Synergistic skill sets, including process design/product development expertise and ESH technical expertise, are required. This synergy may be achieved with certain DFESH design tools.
4. There must be established methods for measuring success. Different types of metrics will be required (e.g., management metrics vs. process engineering metrics), so that some measurement is applied to, and meaningful for, every individual charged with implementation.

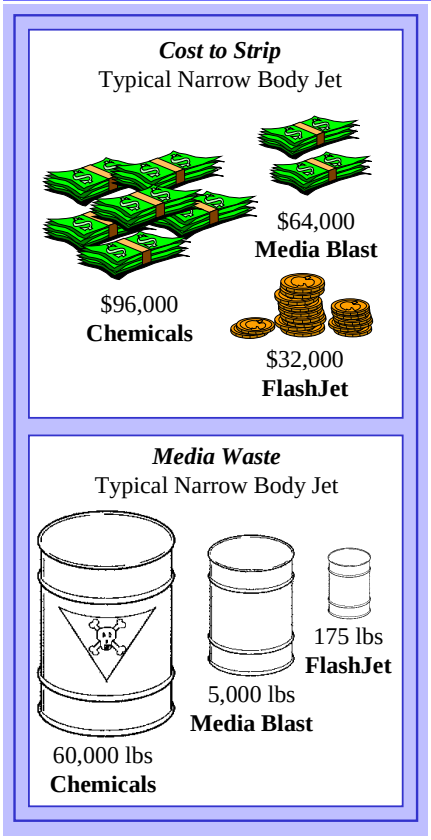
Phases for Implementing a DFESH Program

- Phase Zero, Initialization: DFESH champion identified and senior management support enlisted. DFESH program objectives set.
- Phase One, Initiation: Senior management commitment to DFESH leadership established. Current status (baseline) of DFESH activities assessed, pilot project selected, DFESH awareness increased in pilot team.
- Phase Two, Pilot Testing: DFESH implemented for a single or limited group of projects, results evaluated to assess the potential for implementation of DFESH across the company, tool or methodology gaps identified.
- Phase Three, Implementation: DFESH awareness increased throughout the organization, DFESH principles implemented company-wide, implementation plan realigned to meet company-specific needs.
- Phase Four, Continuous Improvement: DFESH implementation perpetuated and systematically improved using Total Quality Management principles.

Functional Groups included in a DFESH Program

- Senior management
- DFESH champion(s)
- Engineering (including engineering management):
  - product/process development (including R&D)
  - manufacturing
  - facilities
- DFESH engineering
- ESH
- Purchasing
- Marketing/customer support (including strategic product introduction teams)
- Finance/accounting
- Suppliers (chemical and equipment

Design for Environment, Safety, and Health (DFESH) Implementation Strategy



NADEP JACKSONVILLE BECOMES HOME OF THE DOD's FIRST FLASHJET™ MOBILE MANIPULATOR

In 1990, NAVAIR and the Lead Maintenance Technology Center for the Environment (LMTCE) began what has been an eight-year collaboration with McDonnell Douglas Aerospace (now Boeing) in the pursuit of the development and validation of FlashJet (a new depainting technology). By 1991, the LMTCE had NAVAIR corporate commitment and funding to actively participate in the project and ensure that the test criteria addressed unique Navy requirements. The goal of the LMTCE was to investigate the feasibility of the technology as an alternative to conventional stripping materials – primarily chemical stripping and Plastic Media – and to deploy FlashJet to the depot community. As predicted, FlashJet has emerged as the depaint technology of choice where conventional materials are constrained by the stringent regulatory environment.

Description

The business end of FlashJet's depainting system is a Xenon Flash Lamp, which generates high energy impulses powerful enough to ablate the coating from an aircraft exterior or component. The ablative process is immediately followed by a carbon dioxide pellet flush to clean and cool the surface. Both processes are incorporated into the flash head assembly. Two different systems have been developed to deploy the Flash Lamp across an aircraft surface. For small fighter-sized aircraft, a gantry system is available. This is a structure in which the stripping assembly moves across, over and under a plane that is parked with the gantry. Technicians operate the system from a remote glass enclosed control room. Another option is a manipulator arm system (MAS) which allows depainting of large aircraft such as the P-3 Orion. The stripping assembly is attached to the end of a manipulator arm and maneuvered around an aircraft by a tractor-like vehicle. The system is operated from a control platform attached to the front of the vehicle. FlashJet technology has several benefits, including significant reductions in hazardous materials, hazardous wastes, turn-around-time, and selective coatings removal (the ability to remove topcoats of paint and leave primer coats intact).

Spring 1998

Funded by the Navy's Strategic Environmental Research & Development Program (SERDP) and NAVAIR's Aviation Pollution Prevention Program, a US Navy P-3 Orion aircraft in Hanger 122, the Demonstration/Validation efforts began. The prototype technology and its capabilities were fully demonstrated during May and June. At the completion of the effort, the system's capability to access and strip the surface coating of the P-3 and to perform selective stripping (i.e. leaving the primer paint intact) had been successfully validated.

Future Plans

NADEP Jacksonville views the FlashJet technology as a way of reducing its dependence on hazardous depaint media and of achieving environmental compliance but also as a way of decreasing turn-around-time for stripping aircraft. In 1999, NADEP Jacksonville plans to procure a FlashJet gantry system to depaint fighter aircraft and large off-aircraft components. Additionally, the NADEP plans to transition the prototype FlashJet Mobile Manipulator system to a production viable system and to procure a second system to further enhance production efficiency by 2002. [POC: Darrell McKinley, LMTCE, (904) 542-0516 ext. 121, e-mail: mckinley.psd@navair.navy.mil.

This article appeared in the *"Navy Environmental News, Currents,"* Summer 1998.■

WIRE ARC SPRAY PROVIDES LONG-TERM CORROSION PROTECTION REDUCING ENVIRONMENTAL IMPACT OF CORROSION CONTROL AND REPAINT OPERATIONS

Over the past three years the Air Force Corrosion Program Office (AFCPO) has sponsored several pollution prevention projects designed to significantly reduce or completely eliminate the need to perform corrosion repair and repainting of vital but often forgotten Air Force assets such as general purpose bombs and communication and radar towers as well as more visible assets such as vehicles and aircraft maintenance stands. The success of each of these projects hinges on the successful adaptation of a decades old technology called thermal spray metallizing to meet the challenge of providing an effective corrosion resistant coating while complying with today's strict environmental and occupational health standards.

Thermal spray technology has been proven to provide corrosion protection of 50 years or more on iron and steel structures in highly corrosive marine environments. Recent commercial advances in wire arc spray technology, a variant of thermal spray, led to the development of portable spray units designed and built specifically for high-production field application of metallized coatings. In the wire arc spray system two wires, in this case zinc and aluminum, are given opposite electrical charges and simultaneously fed into an application gun. As the two wires are brought together the electrical arc between them causes the wire to melt. The molten metal is then sprayed onto the surface being coated by a stream of compressed air coming through the application gun. As the molten metal cools, it forms a continuous corrosion protective barrier.

The idea of using the wire arc spray was born out of a pollution prevention project initiated in by the AFCPO in 1994 to find a permanent solution to the well documented problem of "rusty" bombs. The Air Force stockpiles large quantities of cast iron general purpose bombs in several areas around the world. Since many of the bombs are stored outdoors in highly corrosive tropical locations they are extremely susceptible to corrosion. Current estimates are that the Air Force is spending in excess of $7M annually in an often futile attempt to control the corrosion on these bombs, using antiquated environmentally and occupationally hazardous materials and processes. At Kadena AB alone there are approximately 60,000 bombs, each of which is cycled through the bomb renovation plant every 5 years to maintain serviceability. During renovation every bomb is sandblasted and repainted resulting in a continual pattern of volatile air emissions, hazardous waste generation, and personnel exposure to hazardous materials. This issue has been repeatedly identified by the AFCPO during their corrosion surveys of the overseas major air commands (PACAF and USAFE).

The AFCPO evaluated the use of powder coatings on the exterior of the bombs as a long-term corrosion protective finish. The Contractor initiated an extensive test program to determine the suitability of the powder coat technology for both the corrosion protection and the safety during application. While the powder coat system met or exceeded the performance requirements, the Contractor found that it could not be applied without exceeding the maximum safe working temperature of the bombs. After determining the powder coat system was unsafe, the Contractor recommended the use of the wire arc spray technology.

With AFCPO approval, SAIC began a test program to evaluate and optimize the wire arc spray for use on the bombs. Extensive testing on instrumented bomb casings showed that the wire arc spray could be applied without exceeding the maximum safe working temperature. Based on the test results the Air Force Weapon Safety Group approved development and testing of a prototype specifically designed for the Kadena bomb renovation plant. After the Contractor designed, built and successfully tested an automated wire arc spray system on live bombs the Weapon Safety Group approved installation of the automated system in the Kadena plant. The Contractor installed the automated system in the bomb renovation plant and completed the operational checkout in April 1996. Because the metallized coating applied to the bombs is naturally corrosion resistant the Air Force was able to stop using the solvent-borne, chromate and lead containing paints and primers previously used for corrosion protection and start using an environmentally compliant acrylic latex sealant to paint the bombs the required olive drab color. This change significantly reduced the VOC emissions

and completely eliminated the hazardous waste stream attributable to the bomb repainting operation. For all practical purposes the wire arc spray may provide a lifetime of corrosion protection with one single application of the metallized coating.

Based on the success at Kadena, the AFCPO initiated several other projects designed to take advantage of the wire arc spray capabilities. A mobile bomb renovation plant is currently under development to provide the wire arc spray capability to any bomb storage location facing similar issues as Kadena. Also, using repeat findings documented during the MAJCOM corrosion surveys, they identified severe ongoing corrosion problems with radar and communication antennas and towers and special purpose vehicles particularly in the Pacific theater. Like the bombs at Kadena, the Air Force was expending a large amount of resources in a futile attempt to control the corrosion on these assets. After further defining the extent of the problem the AFCPO decided to test the wire arc spray system on an antenna tower at Kadena AB and on special purpose vehicles at Anderson AFB. In both cases the AFCPO arranged for a complete wire arc spray system to be delivered and set up and have personnel from the local unit trained in its use. Upon successful completion of these test projects the AFCPO will take action to make the wire arc spray the preferred corrosion protective coating for all antennas and special purpose vehicles. The AFCPO also initiated a test of the wire arc spray system on an aircraft maintenance stand used in the aircraft depaint hangar at Robins AFB. Because these stands are repeatedly exposed to the paint remover used to strip the aircraft, the current paint system is ineffective in preventing corrosion.

For more information on wire arc spray technology and its potential applications, please contact Mr. Dave Ellicks, AFRL/MLSSR (AFCPO), at DSN 468-3284.

This article was submitted by Mr. Randy Straw, Science Applications International Corporation. ■

Project Description	Organization
Cleaning & Surface Prep	
Laser Cleaning for Oxygen Systems	AFRL/MLQE (Tom Naguy)
Laser Cleaning of Organics	AFRL/MLQE (Tom Naguy)
Sol-Gel Coating Formulation	AFRL/MLBT (Mike Donley)
Sol-Gel Tech. for Low-VOC, Non-Chromated Adhesive/Sealant Apps	AFRL/MLSA (Jim Mazza)
Non-Chromated Conversion Coatings for IVD Aluminum	AFRL/MLQE (Jim Hurley)
Non-Chromated Conversion Ctgs for Large Area Applications (DO 34)	AFRL/MLQE (Lt G. Graziano)
Multi-Layer Thin-Film Coatings for Aluminum Alloys	AFRL/MLQE (Lt G. Graziano)
Aqueous Non-Chromate Conversion Coatings for Aluminum Alloys	AFRL/MLQE (Lt G. Graziano)
Paint, Materials & Processes	
Large Area Powder Coating	AFRL/MLBT (Lt R. Passinault)
Environmentally Compliant (LO) Coatings High Velocity Therm Spray (HVTS)	AFRL/MLBT (Mike Halliwell)
DO11 Non HAP, Low VOC Non-Chromated Primer & Topcoat	AFRL/MLSA (Lynn Pfledderer)
DO12 Replacement Paint Stripper for Landing Gear	AFRL/MLSA (Lynn Pfledderer)
DO38 Isocyanate-Free A/C Topcoat	AFRL/MLBT (Mike Halliwell)
Convergent Spray Technology for LO Coatings	AFRL/MLSA (Tom Naguy)
Atmospheric and Reactivity Studies of Air Force Fuels and Chemicals	WUD-TY.2
Plating	
Laser-Based Techniques for Replacing Chrome Plating	AFRL/MLPJ (Capt K. McCartney)
DO15 Opt & Char Env Acc Thin Films Ctg Matl, Replace Chrome	AFRL/MLQE (Jay Tiley)
DO47 Cadmium Replacement Connectors	AFRL/MLSA (George Slenski)
DO53 Heavy Metal Alternatives for Internal Surfaces	AFRL/MLQE (Lt G. Graziano)
DO49 HVOF Coating Characterization	AFRL/MLQE (Lt G. Graziano)
Other POL. R&D Support	
Runway Deicer Materials Compatibility Testing	AFRL/MLSA (Lee Gully)
DO52 NDI Implications of Applique Technology	AFRL/MLSA (John Brausch)
Fate & Transport of New AF Materials	WUD-TY.2

For further information regarding these on-going/joint collaboration projects, please contract Major Michael Boucher, AFRL/MLQE at (850) 283-6293

COMPACT DISC (CD) FOR IDENTIFYING AND REDUCING HAZARDOUS MATERIAL (HAZMAT) USAGE REQUIREMENTS AVAILABLE THROUGH PRO-ACT

PRO-ACT, the environmental information exchange service of the Headquarters Air Force Center of Environmental Excellence, Environmental Quality Directorate (HQ AFCEE/EQ), has developed a Compact Disc (CD) containing the Portable Document Format (PDF) HAZMAT Search Tool (PHAST) and Process and Potential Alternative (PAPA) Database software programs. These programs are designed to assist the user in identifying and reducing/eliminating hazardous materials requirements.

The PHAST program was developed by HQ AFMC/ENBE as an economical means of reviewing electronic technical data in searchable portable document format and identifying references to environmentally targeted chemicals and products. Installation and operation of the program requires users to have the commercially available Adobe™ Acrobat™ Exchange software package already installed on their computer. Version 1.0 of the PHAST program can search for chemicals targeted for reduction in the following program areas: Class I and II Ozone Depleting Substances (ODSs); Environmental Protection Agency (EPA) 17 chemicals; AFMC 24 chemicals; and Toxic Release Inventory (TRI) 313 chemicals. Additionally, the PHAST program can be modified by users to include chemicals from other program listings such as Hazardous Air Pollutants (HAPS). PRO-ACT will provide updates of the PHAST program to users as environmental programs are added, deleted, or modified, and can answer technical questions concerning the program's installation and use.

The PAPA database, also initially developed by HQ AFMC/ENBE, was designed to facilitate cross-feeding of "environmentally friendly" alternatives across the weapon system community. It has been extensively modified and upgraded to a fully searchable Microsoft Access database containing potential product substitutions and process changes in 84 specific maintenance processes obtained from DoD, industry, and manufacturing sources. PRO-ACT will distribute updates to the potential alternative listing each quarter.

For a copy of these tools, please contact Margaret McGhee or Christ Taylor at PRO-ACT directly at DSN 240-4240. If you have questions about PRO-ACT in general, please contact the Air Force PRO-ACT Program Manager, Capt Laura McWhirter at DSN 240-4192.■

EDITORIAL

With this issue, the MONITOR transitions to a quarterly publication and will cross-feed environment, safety, and health related issues across the entire life cycle of Air Force Weapon Systems. Additionally, the HQ Air Force Materiel Command (AFMC) Pollution Prevention Integrated Product Team (AFMC P2IPT) now serves as the advisory board for the publication. Other partnerships that have been formed include the participation of Mr. Fred Missel from Boeing, who has agreed to spearhead the MONITOR's effort to cross-feed Design for the Environment related issues/information through a regular column. We need other active participants in this effort and look forward to hearing from you.

The major articles published in the MONITOR from January 1995 - December 1997 have been summarized on pages 17 to 20 under program, tools, success stories and policy. During the course of the next year, the MONITOR will take specific articles listed in these tables and update the current status of some of these projects/programs. If there are specific articles that you would like the MONITOR to validate and cross-feed the current status, please let us know. If an article related to your organization is listed in these tables and you would have a direct link to your web site, please also let us know.■

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May 1995 (Volume 2 Number 4) Roles and Responsibilities of AFMC Pollution Prevention Integrated Product Team (PPIPT); SERDP Case Study From the ODC Information Exchange
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November 1995 (Volume 2 Number 7) General Franklin Emphasizes the Need for Joint Solutions ESC Hosts Center Working Group Meeting SM Representatives Discuss Institutionalizing WSP2 Lt Col McCarty Speaks With MONITOR Center Working Group Meeting Summary
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March 1996 (Volume 3 Number 2) General Smith Emphasizes the Need to Build a "Lean, Mean, and Green" Air Force Impact of Environmental Regulations and Pollution Prevention Policy on the C-141 Flight Line at Robins Air Force Base Overview of the WS-SM HAZMAT HMRPP ASC Leads the Air Force Participation in JG-APP Initiative
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September 1996 (Volume 3 Number 5) ESOH Paradigm: Partnering For Performance The ESOH Initiative CTSC Addresses Needs For Coating Systems and Coating Removal Process Technologies Overview of the USAF Investment Strategy For Coating Systems and Coating Removal Processes
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March 1997 (Volume 4 Number 3) C-17 Globemaster III Overview of the C-17 P2 IPT C-17 Hosts Expanded P2 IPT Meeting WS P2 CWG Update
May 1997 (Volume 4 Number 4) The F-22 Raptor Next-Generation Fighter Unveiled F-22 Program Integrates Environment, Safety, and Health Considerations into the EMD Contract Language Edwards AFB Integrates the BEE Into F-22 Flight Test Operations
July 1997 (Volume 4 Number 5) The Three Principles of the AF Environment, Safety, and Occupational Health (ESOH) Program Tinker AFB Develops a Pollution Prevention Investment Strategy
September 1997 (Volume 4 Number 6) Keynote Speaker at Joint Service P2 Conference Addresses Pollution Prevention in Acquisition Overview of AETC's ESOH Needs Identification Process Summary of the JG-APP Initiative Within the Air Force
November 1997 (Volume 4 Number 7) The Propulsion Product Group Leverages Resources Across Weapon Systems and Services Overview of AF Engines by Weapon System and OEM (Partial) Overview of the PEWG PEWG's Turbine Engine Technical Data Program

WSP2 MONITOR - Tools Related Articles [Jan 95 - Dec 97]
January 1995 (Volume 2 Number 1) Acquisition Management of Hazardous Materials (AMHM) An Overview of the AMHM Program Model Contract Language - ASC Hazardous Materials Data Repository (HMDR) Functional Training - APP Training Hazardous Materials Management: From Developing g a "Hit List" to Changing Technical Orders
February 1995 (Volume 2 Number 2) An Overview of the Funding Estimator Tool for Weapon System Pollution Prevention
March 1995 (Volume 2 Number 3) Overview of the Current Status of Acquisition Pollution Prevention Tools Overview of the Air Force Acquisition Model (AFAM) Navy's Pollution Prevention Technical Library - Mr. Larry Hill (805) 982-4795
May 1995 (Volume 2 Number 4) Technology Update Q&A: Hazardous Materials Alternatives
July 1995 (Volume 2 Number 5) PEA: An Environmental Master Plan For Environmental Risk Management ASC Hazardous Materials Guide Technical Manual on Alternatives to Ozone Depleting Solvents - ICOLP (202) 737-1419 SA-ALC Develops P2 Guide for SMs Enviro$ense: EPA's New Electronic Library
September 1995 (Volume 2 Number 6) C/KC-135 Master Plan Joint Stars PEA WWW Sites ODS Milspecs on WWW
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May 1996 (Volume 3 Number 3) ASC WSP2 Training AAOS Training P2 Life Cycle Assessment
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March 1997 (Volume 4 Number 3) Re-Refined Oil Available From DSCR
May 1997 (Volume 4 Number 4) F-22 Establishes an Information Management Tool for Integrating ESH Considerations Into Weapon System Design SMC Input: Environmental, Safety, and Health Management and Cost Handbook to be Expanded HQ AFMC/LG-EV Input: Changes to Military Winter Aircraft Deicing Practices and AFMC Concerns
September 1997 (Volume 4 Number 6) ESC Input: Overview of the Tactical Environmental, Safety and Health (ESH) Action Guide SMC Input: Making Smart Choices in Material Selection HSC Input: Toxicology and Chemical Health Effects Evaluations
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WSP2 MONITOR - Success Story Related Articles [Jan 95 - Dec 97]
February 1995 (Volume 2 Number 2) Technical Evaluation: Substituting M-Pyrol for Methyl Ethyl Ketone in Removing Excess Sealants and Adhesives on Aircraft and Ground Support Systems - Catherine Gastauer (210) 925-7391
March 1995 (Volume 2 Number 3) Case Study on Solvent Replacement [Elimination of 1,1,1-TCE to remove wax from masked parts after chrome electroplating]
May 1995 (Volume 2 Number 4) Success Stories on the Phase Out of CFC-113 and 1,1,1-Trichloroethane (Stratospheric Ozone Information Hotline 1-800-296-1996)
July 1995 (Volume 2 Number 5) Gas Generated Integrated Fire Suppressant Developed By Olin
September 1995 (Volume 2 Number 6) NAVSEA's NOC WR-ALC Tests CO_2 Process SA-ALCs TO Revisions
November 1995 (Volume 2 Number 7) Bell Helicopter Incorporates P2 into the V-22
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November 1996 (Volume 4 Number 1) F-15 Aircraft Success Story SM-ALC Develops Process to Reformulate Spent Media from Depainting Operations Halon 1301 Replacement in DoD and Commercial Applications
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January 1996 (Volume 3 Number 1) Ban on Production of Class I ODS Goes Into Effect Montreal Protocol Update EPA SNAP Program Overview AF ODS Milestone Policies
March 1996 (Volume 3 Number 2) Overview of the 1994 TRI for DoD
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